Statement of Work - ISS Dewar

1.0 General Background

NASA will be procuring a Dewar (Fig 1) for use in a cryogenic experiment on the International Space Station. The instrumented Dewar will be integrated with a receiver tank, and used in a demonstration of the storage and transfer of liquid methane in zero g. Constraints on the experiment timeline will require the tank to be maintained with zero boiloff for six months or more.

2.0 Vendor Qualifications

Vendor shall be capable of design, fabrication and certification in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII Division 1 or Division 2, or in accordance with AIAA S-080.

Vendor must have a Quality Management Program which has been certified to be compliant with ISO 9001:2008, or BPVC Sec VIII Appendix 10.

Aluminum welding capabilities shall be in accordance with BPVC Sec VIII Part UW

Vendor shall establish and implement a system to review and take action, as necessary, on GIDEP Alerts.

Vendor shall maintain a calibration system based on standards traceable to NIST. (A system compliant with ANSI/NCSL Z540 is preferred).

3.0 Technical requirements

3.1 Mass

The dry mass of the Dewar shall be no more than 50 kg.

3.2 Envelope and interfaces

The outer envelope of the Dewar shall be no more than 65 cm diameter and 60 cm high.

The top and bottom heads of both the tank and vacuum shell shall be removable. Any MLI blanket on the tank shall be fabricated to accommodate this feature.

The top head of the vacuum shell shall have two access ports of at least 5 cm clear diameter.

The top head of the tank shall have two access ports of at least 5 cm clear diameter, and one of at least 10 cm clear diameter.

The bottom head of the vacuum shell and the tank shall each have three access ports of at least 5 cm clear diameter.

The bottom head of the tank shall be a flat plate at least 1 cm thick.

The space between the two bottom heads shall allow a free volume for internal manifold components of at least 45 cm diameter and 15 cm height.

The external structural interface for the Dewar shall be developed by the vendor in cooperation with the customer.

3.3 Volume

The tank volume shall be at least 50 liters, with a strong desire for more volume within the limits of dry mass.

3.4 Orientation

The Dewar shall comply with all performance requirements when operated in any orientation. The Dewar shall be designed for fill and drain operations in both the "Up" and "Down" orientations. (See Fig 1)

3.5 Thermal Requirements

The Dewar shall operate in both active and passive modes, in an environment that may vary between -40°C to +50°C.

3.5.1 Active Mode

In a 20°C operating environment, the active mode shall use no more than 50W for a flight-capable cryocooler of the vendor's choice to maintain the tank at a constant temperature of 80K with no venting.

The vendor shall provide non-flight electronics to drive the active mode for all ground test activities. Power dissipated in the cryocooler electronics will not be counted against the 50W power allocation. The customer will assume responsibility for acquiring flight cryocooler electronics.

3.5.2 Passive Mode

In a 20°C operating environment, the passive mode with no venting shall allow no more than 2.0W of heat load on the tank at 80K, with zero electric power. For certain servicing operations where power will not be available for active mode operation, the tank shall have a cooling loop for liquid nitrogen flow which will allow at least 1.0 gram/sec flow rate at a vapor quality between 0-90%.

3.6 Operating Lifetime

The dewar shall be capable of running in active mode for a duration of two years of ground test and flight operations. MTTF of the cryocooler shall be at least 20,000 hrs.

3.7 Pressure, Temperature and Loads

The internal MAWP or MEOP of the tank shall be at least 0.28 MPa over a temperature range of -205°C to +50°C, and of the vacuum shell at least 0.10 MPa over a temperature range of -40°C to +50°C. Both shall be capable of one atmosphere external pressure for leak check operations at 20°C. The tank and vacuum shell shall both be provided with appropriate pressure relief devices.

The Dewar shall be designed for typical ground shipping loads. As a minimum, the Dewar shall be designed for a 10 g acceleration in any direction, simultaneous with pressure loading and with a full load of methane. The Dewar shall be designed for a minimum natural frequency of greater than 50 Hz.

3.8 Leak

The Dewar shall be leak tight to better than $1x10^{-8}$ standard cc/second of GHe, as measured by a calibrated helium mass spectrometer.

3.9 Handling

The vendor shall provide a cart or work stand designed and tested for the full wet weight of the Dewar, and which enables the Dewar to be inverted. The Dewar shall be provided with lift points designed and rated for the dry weight of the Dewar.

3.10 Shipping

The vendor shall provide a shipping container for the Dewar, consistent with the shipping loads of Sec 3.7.

4.0 Programmatics

4.1 Customer access

The vendor shall allow reasonable access for the customer's Quality Assurance or Engineering personnel to witness any phase of the production of the Dewar, at the contractor's facilities or at any subcontractor.

4.2 Customer reviews

At a location of its choosing, the contractor shall conduct technical reviews with the customer, as listed in Deliverables. At least two weeks advance notice shall be given for each of the reviews.

A special case of this is a customer review of the dewar structure early in the program. While not scheduled as an on-site review, the structural review documents (Deliverable 0006 a and 0006 b) will be used by the customer to assess compliance with flight load requirements. The customer will provide a response within fifteen business days of receipt.

4.3 Structural analysis task sharing

The vendor shall bear all responsibility for the design and fabrication of the Dewar for pressure and temperature environments. The customer will take primary responsibility for structural analysis related to the space flight environment.

4.4 Testing

The vendor shall be responsible for verifying by test that the Dewar complies with each of the technical requirements of Section 3, except for the acceleration and frequency requirements, which will be verified by the customer.

Vibration qualification will be performed by the customer at NASA. The vendor is welcome to witness the qualification testing.

Liquid nitrogen may be used in place of liquid methane for all of the testing at the vendor's location.

4.5 Delivery schedule

The Dewar should be delivered within 14 months of contract initiation, including 3 months of total schedule allowance for customer/contractor interaction on analysis and review of the dewar structure.

5.0 Quality Management System

The Developer/Contractor shall have a Quality Management System that is compliant with the minimum requirements of ANSI/ISO/ASQ Q9001 or equivalent. The Developer/Contractor's Quality Manual shall be provided in accordance with the SOW (refer to DID 2-1). Certificates issued to ANSI/ISO/ASQ Q9001: 2000 will have a maximum validity of 3 years from the publication date of ANSI/ISO/ASQ Q9001: 2008, SAE AS9100:2009 and ISO TR 10013, SSC-RQMT-000008 (latest revision), SSC-PLAN-000009 (latest revision).

5.1 Supplemental Quality Management System Requirements

Some assurance related activities are not covered by ISO requirements. These activities are identified in the following sections and should supplement the ANSI/ISO/ASQ 9001 requirements. The Developer/Contractor shall provide a Mission Assurance Plan describing how the requirements in this document will be met. (refer to DID1-1).

5.2 Configuration Management

The Developer/Contractor shall document and maintain a configuration management system to properly manage change control and the functional and physical characteristics of configuration items during design, fabrication, assembly, and testing. The Developer/Contractor's Configuration Management Plan shall be available for review by GSFC.

5.2.1 Control of Nonconforming Product

The Developer/Contractor shall have a closed loop system for identifying and reporting non-conformances, ensuring that positive corrective action is implemented to preclude recurrence and verification of the adequacy of implemented corrective action by audit and test as appropriate. The system shall include a nonconformance review process, which shall consist of a preliminary review and an MRB. NASA shall be provided access to any NASA related nonconforming reports and corrective action information.

5.2.2 Material Review Board

At Developer/Contractor/supplier facilities, the NASA/Government representatives will participate in MRB activities as deemed appropriate by GSFC.

5.2.3 Reporting of Non-conformances

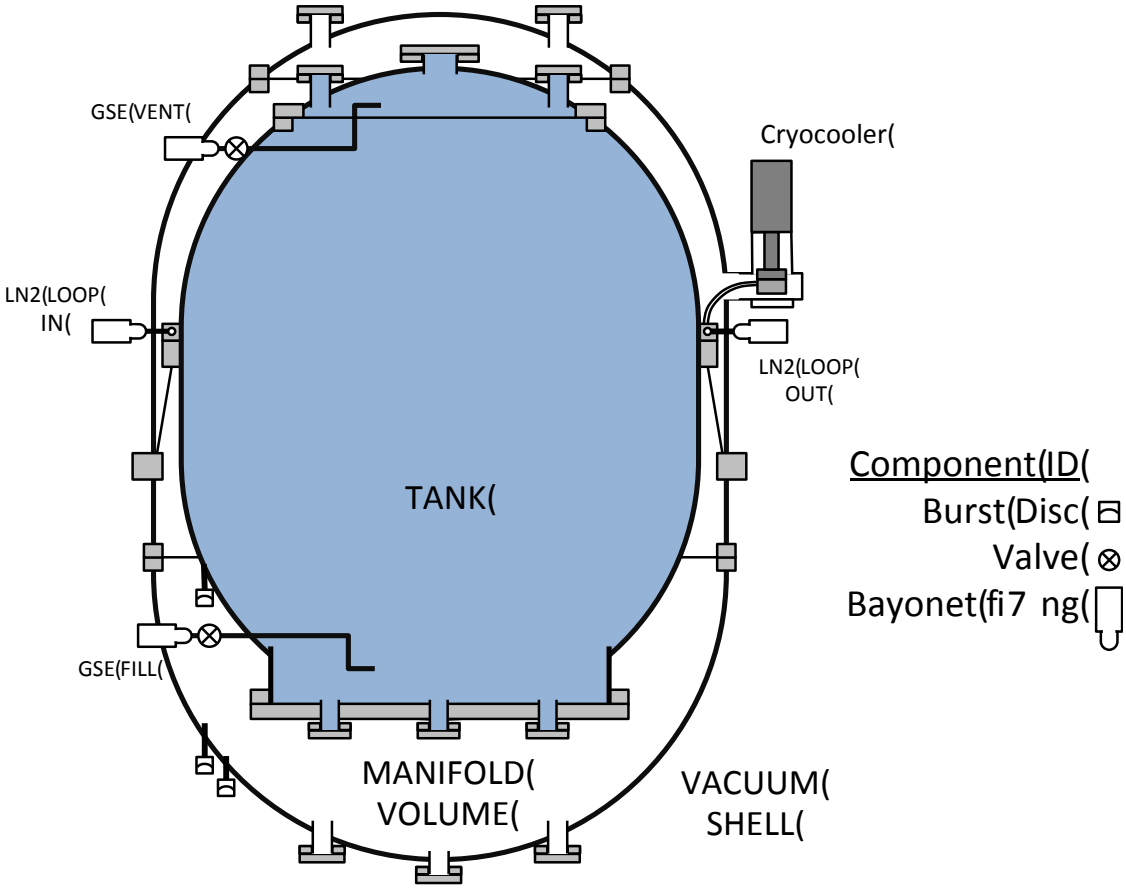
Reporting of operational non-conformances shall begin with the first power application at the start of end item acceptance testing or the first operation of a mechanical item; it shall continue through formal Government acceptance of the end item.

5.2.4 Control of Monitoring and Measuring Devices

Test and measuring equipment shall be properly calibrated. Testing and calibration laboratories shall be compliant with the requirements of ISO17025, "General Requirements for the Competence of Testing and Calibration Laboratories".

5.2.5 Flow Down

The Developer/Contractor's QA and safety programs shall ensure proper flow-down and verification of requirements to all suppliers.



- Fig 1. Features of the Dewar include removable heads on the tank and vacuum shell, access ports, an internal manifold volume, a cryocooler for zero boiloff, and a liquid nitrogen cooling loop. This schematic shows the Dewar in its "Up" orientation; inverted is the "Down" orientation.

Acronym List

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASQ	American Society for Quality
BPVC	Boiler and Pressure Vessel Code
GHe	Gaseous Helium
GIDEP	Government-Industry Data Exchange Program
GSFC	The Goddard Space Flight Center
ISO	International Organization for Standardization
MAWP	Maximum Acceptable Working Pressure
MEOP	Maximum Expected Operating Pressure
MLI	Multi-Layer Insulation
MRB	Material Review Board
NASA	The National Aeronautics and Space Administration
NCSL	National Conference of Standards Laboratories
NIST	National Institute of Standards and Technology
QMS	Quality Management System